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RESEARCH ARTICLE

The Effects of Indoor Air Quality on Health and Productivity of Workers in a Manufacturing Industry in Malaysia

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ABSTRACT - Indoor Air Quality (IAQ) has a significant impact on health and quality of life in general. IAQ can be affected by various chemicals, including gases (i.e., carbon monoxide, ozone, radon), volatile organic compounds, particulate matter and fibres, organic and inorganic contaminants, and biological particles such as bacteria, fungi, and pollen. Studies of buildings have indicated that poor IAQ can cause health problems, affect occupants' productivity. This research analyses how the indoor air quality can affect the health and productivity of workers in a manufacturing industry in Malaysia. As for the health effects, poor indoor air quality can give short-term effects as well as to a long-term risk. To complete this study, a set of questionnaires were distributed to 50 workers in the manufacturing industry in Malaysia. The findings indicated a modest positive correlation between IAQ and worker health, while significant correlation was observed between IAQ and productivity. In conclusion, there are many actions and recommendations that can be contemplated in protract the best and excellent reputation and performance of the company moreover by considering improving the indoor air quality, health and productivity of workers.

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1. INTRODUCTION

Higher levels of productivity provide an organization and its employees with various advantages. In addition, productivity tend to maximize organizational competitive advantage through cost reductions and high quality of output [1]. A literature review conducted by [2] has revealed that employee's productivity was determined by various measures including work life balance, motivation, work environment, training, stress level, compensation, performance appraisal and job satisfaction. Choosing the right determinant for performance measurement can also improve the decision making either in policy or management [3]. Training is an important factor that will increase employees' skills and competency which influence the workers productivity and organizational performance [4]. Worker's health and wellbeing is about ensuring the employees are safe, healthy and engaged with work. The health effects of inhaled biological particles can be significant, as a large variety of biological materials are present in indoor environments. The health effects of indoor air pollution have received relatively little attention from the scientific community. Health problems resulting from poor indoor air quality are not easily recognized and may affect a patient's health years after the onset of exposure. Workers not only must be safe but also healthy, satisfied and engage if not, it will be very challenging for business leaders to run a business.

In the last few decades, Indoor Air Quality (IAQ) has received increasing attention from the international scientific community, political institutions, and environmental governances for improving the comfort, health, and wellbeing of building occupants. Several studies on this topic have shown both qualitative and quantitative IAQ variations through the years, underlining an increase in pollutants and their levels. IAQ has a significant impact on health and quality of life in general. IAQ can be affected by various chemicals, including gases (i.e., carbon monoxide, ozone, radon), volatile organic compounds (VOCs), particulate matter (PM) and fibres, organic and inorganic contaminants, and biological particles such as bacteria, fungi, and pollen [5]. Indoor air quality or IAQ is what we experience as the temperature, humidity, ventilation, and chemical or biological contaminants of the air inside buildings [6][7]. Studies of buildings have indicated that poor IAQ can cause health problems, affect occupants' productivity [8]. The study found that air quality in a building significantly influences work productivity and may contribute to Sick Building Syndrome (SBS). Findings show that SBS symptoms are linked to various personal characteristics [9].

2. METHODS AND MATERIAL

This research using questionnaire as the instruments because it is very easy to use and typically can be used for large-scale studies. In addition, questionnaires also very cost-effective. Quantitative researchers may also select written questionnaires that are more detailed and can be easily accessed by a large sample [10]. In this research, non-probability sampling procedure is used to get the sample from respondents and the design approach of this non-probability sampling that will conduct is convenience sampling method. According to [11], the convenience sample is usually selected for

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studies that are conducted at the right time and place. As advantage, this method is commonly used and are less expensive. They cannot be controlled or measured due to the biases and the variability in the sample. Convenience sampling is a very easy alternative method of sampling which usually carried out in nearest location or internet carrier.

This study consists quantitative method within the process in collecting data. The main focus of this method is on gathering data through primary sources such as survey feedbacks from the target group. This study also used questionnaire as other data collection method. Therefore, a set of questionnaires created towards collecting the information from the respondents as primary data sources. The respondents use the 5-point Likert Scale to rate the questions. There were four sections given which are section A: Demographic Information, B: Indoor Air Quality Scale based on workers evaluation, C: Health state among workers in Panasonic Manufacturing Malaysia, D: Productivity of workers in manufacturing industry in Malaysia. Statistical Package for Social Science (SPSS) software were used in this study to analyse and transform the data collected into reliable and valid information for the findings. Descriptive and inferential analyses were used to study the relationship between indoor air quality on health and productivity of workers in Panasonic Manufacturing Malaysia.

This analysis is a process that use three phases which are mean, percentage, and frequency to calculate the level of indoor air quality, health state and the productivity of workers. All data collected from section A, B, C will be analysed using this process. Worker level of productivity, health and indoor air quality will also be measured using the ranges of values that will be divide into low, medium, and high. The level of each dimension will be measured using the mean score ratio. The calculation are as follows:

$$Level = \frac{Highest\ mean\ score - lowest\ mean\ score}{Total\ nmber\ of\ levels} \quad (1)$$

Inferential statistic also will be used in this study which is Pearson correlation to inspect the relationship between the variables. In addition, the variables will be presented by index number 1 and 0. Low score indicates a weak correlation while a high score shows a strong relationship between these variables.

3. RESULTS AND DISCUSSION

This chapter contains a detailed presentation and discussion of data analysis and the results of this study. The questionnaire was given to the workers in manufacturing industry in Malaysia where 50 respondents participated, and the results were evaluated. The findings are separated into four sections which are demographic information, indoor air quality evaluated by workers, health of workers and productivity of workers. The demographic section was assessed on age, gender, work experience, department, and level of education. While the indoor air quality, health and productivity evaluation of the workers were using the developed question from NIOSH well-being Questionnaire (WellBQ) [8].

3.1 Demographic Information of the Respondents

From the research, 50 respondents were recorded participating in answering this questionnaire and their information was tabulated in Table 1. From these, it was recorded that the major respondents are from male workers (f = 27) which is only four number different with the female (f = 23). The next information was the group of age of the respondent's where the group of (18-23 years old) recorded the highest participation (f = 30). Meanwhile, the least responders with only (f = 2) are from (30-35 years old) group. In the other hand, the group of age (24-29 years old) and (40 and above) recorded the same number which are (f = 9). From the work experience part, largest group of respondents having experience for 1 year or less (f = 23) followed by 5 years or more (f = 13), 2 years of experience (f = 7), 3 years' experience (f = 5) and the least respondents having experience for 4 years (f = 2).

Moving to the work department, the respondents are coming from different departments and the result are as follows, where the bulk of the respondents were from production department (f = 15) and there were only (f = 1) for each of these departments which are from Environment, Electrical, Health, Healthcare and Research and Development (R&D). Meanwhile there were (f = 10) for Support (IT, Quality, Maintenance, Human Resources), (f = 9) from marketing and sale department, (f = 6) from Engineering department, (f = 3) from Finance department and (f = 2) from shipping and receiving department. Finally, was the information regarding the level of education of the respondents. It recorded that the most respondents having degree certificate (f = 22) followed by SPM certificate (f = 14), diploma certificate (f = 10), master certificate (f = 2) and STPM and LKM certificate (f = 1). The breakdown of the demographic information is as in the Table 1.

Table 1. Frequency and percentage of demographic information

		Frequency	Percentage (%)
Gender	Male	27	54
	Female	23	46
Age	18 -23	30	60
	24 -29	9	18
	30 – 35	2	4
	40 and above	9	18
Work experience	1 year or less	23	46
	2 years	7	14
	3 years	5	10
	4 years	2	4
	5 years and above	13	26
Work department	Environment	1	2
	Electrical	1	2
	Engineering	6	12
	Finance	3	6
	Health	1	2
	Healthcare	1	2
	Marketing & Sale	9	18
	Production	15	30
	R&D	1	2
	Shipping & receiving	2	4
	Support (IT, Quality, Maintenance, Human Resources)	10	20
Education level	Diploma	10	20
	Degree	22	44
	LKM	1	2
	Master	2	4
	SPM	14	28
	STPM	1	2

3.2 The Level of Indoor Air Quality in Manufacturing in Malaysia

From the indoor air quality component in the questionnaire, it has recorded that the mean is (M = 3.1657) with a standard deviation of 0.5890. In addition, it is found that the highest mean score recorded was (M = 5.00) and the lowest reading was (M = 2.14). As we can see, from the indicator stated in Table 2 the level of the indoor air quality in Panasonic Manufacturing Malaysia is moderate because the result for the mean is in the range between 2.34 – 3.67. Based on the findings, it means that the ventilation there is pretty well-maintained due to the particular circumstances that the air quality there was not in excellent state but also not in a very unsatisfactory state.

Table 2. Finding on the level of indoor air quality

Variable	Finding	Level
Level of indoor air quality	Mean = 3.1657 Standard Deviation = 0.5890	Moderate

3.3 The Health State of Workers

Health and wellness of the workers in Panasonic Manufacturing Malaysia can be also considered as in the moderate level as the recorded the mean is (M = 2.405) with the standard deviation of 0.694. Most workers in the company that participated suggest that they have moderate level health, still there are workers that shows their health was not so well and a few of them are in a very good health condition. This mean that most of the workers are maintaining their health mentally and physically and not to forget to their company also contributed little not too much in their workers' health. With these, the workers could contribute more for the company and can also developing the quality of work among them.

Table 3. Finding on the level of the health of workers

Variable	Finding	Level
Level of health of workers	Mean = 2.405 Standard Deviation = 0.694	Moderate

3.4 The Productivity of Workers

The situation is different for productivity of workers compared to the indoor air quality and their health. This is because the productivity is having low level based on the mean (M = 3.706) with a standard deviation of 3.75. Even though the indoor air quality and their health state are in moderate level, their productivity was in low level. This show that more than half of the workers are not too productive. Therefore, it will give a very tough challenge for the company in generating a high quality and quantity of products and also for the reputation of the company.

Table 4. Finding on the level of productivity of workers

Variable	Finding	Level
Level of productivity of workers	Mean = 3.706 Standard Deviation = 3.75	Low

3.5 The Association between Indoor Air Quality with Health and Productivity of Workers

For the relationship between indoor air quality and the health of the workers, the Pearson's correlation coefficient is 0.424 shows that these variables having a low positive relationship. Since, the mean of indoor air quality and health of the workers is in moderate level, therefore, they are having direction linear positive relationship based on Pearson's correlation coefficient. In short, the better the indoor air quality in workplace, the better the health of the workers. Next, for the exact purpose of the relationship between indoor air quality with the productivity of workers, it has recorded the Pearson's correlation coefficient of 0.841 where it shows high relationship between the productivity of workers and indoor air quality. These both variables have different mean level where productivity was actively demonstrated that the workers are not very productive even when the indoor air quality was moderate. To sum up the statement stated, the productivity decreases when the level of indoor air quality decrease.

Table 5. The relationship between indoor air quality on health and productivity of workers

	r	Sig	N
Indoor Air quality and Health of the workers	0.424	.000	50
Indoor Air Quality and Productivity of workers	0.841	.000	50

** Correlation coefficient is significant at 0.01 level

4. CONCLUSION

In conclusion, this positive relationship between air quality with the health and productivity of workers shows that the respondents' assessment could also bring significant results. Hence, the ventilation system must be well taken care of in order to help the workers in maintaining good health state also in generating the best expectation of productivity and performance in order to sustain the reputation and performance of the company.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHORS CONTRIBUTION

Khairul Iman, S. (Data curation; Writing - original draft, Conceptualization; Formal analysis; Visualisation; Supervision)
Nurud Suria, S. (Methodology; Resources Conceptualization; Formal analysis; Supervision)

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